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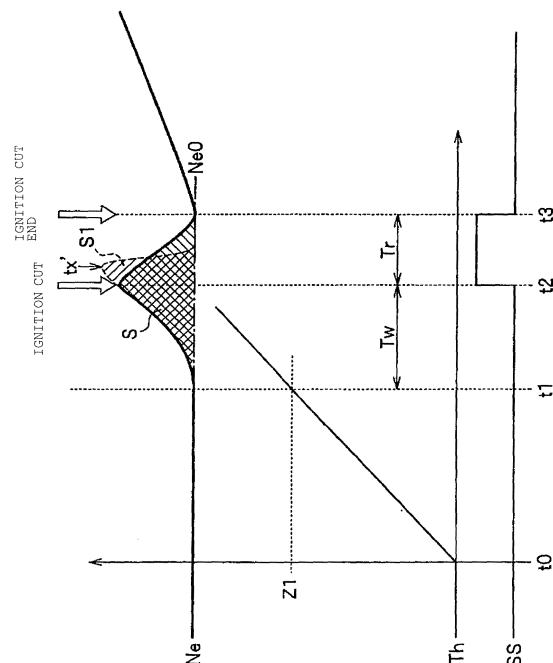
Acceleration shock reduction control system for vehicle

(57)

To provide an acceleration shock reduction control system for vehicle which can reduce a shock at a transition to an accelerating state without deteriorating an acceleration response.

An acceleration shock reduction control system for vehicle includes a control unit (90) which determines a transition from a decelerating state to an accelerating state, and which thus controls the ignition of an internal combustion engine (6) to adjust the output of the engine (6) . In the acceleration shock reduction control system, upon detecting the transition from the decelerating state to the accelerating state, the control unit (90) gives an instruction for an ignition cut which is executed over a predetermined time period (Tr) after a predetermined waiting time period (Tw) elapses.

[FIG. 6]



Description

[0001] The present invention relates to an acceleration shock reduction control system for vehicle such as a motorcycle.

[0002] In general, in vehicles such as motorcycles, an acceleration shock often acts on the vehicle at the transition from a decelerating state to an accelerating state. This acceleration shock is caused by an event in which backlash is taken up. For the purpose of avoiding this acceleration shock, the following configuration has been conventionally proposed. Specifically, in this conventional configuration, shock due to backlash and the like at the transition from a decelerating state to an accelerating state is controlled by retarding the ignition timing of the engine, as well as by adjusting the operating time of a fuel-stage returning control (for example, see Patent Document 1).

[Patent Document 1] Japanese Patent Application Laid-open Publication No. 2004-60528

[0003] However, in the conventional configuration, since the ignition timing is retarded until backlash is taken up after the transition to an accelerating state, it requires time for the backlash to be taken up. In addition, since the ignition timing is gradually returned to normal after the retarding, the acceleration is relatively slow for the throttle opening degree. As a result, although the acceleration shock can be reduced, the engine response is seems to be slow in comparison with a state where the above-described control is not performed.

[0004] In this respect, an object of the present invention is to provide an acceleration shock reduction control system for vehicle, in which the above-described problems associated with the conventional technique are eliminated, and which can reduce, without deteriorating the acceleration response, a shock at the time of accelerating the vehicle.

[0005] For solving the above-described problems, the present invention provides an acceleration shock reduction control system for vehicle. The acceleration shock reduction control system includes control means which determines a transition from a decelerating state to an accelerating state, and which thus controls the ignition of an internal combustion engine to adjust the output of the engine. In the acceleration shock reduction control system, upon detecting the transition from the decelerating state to the accelerating state, the control means gives an instruction for an ignition cut which is executed, after a predetermined waiting time period (T_w), over a predetermined time period (T_r , T_r' , T_r'') or a predetermined number of ignition cycles. According to this invention, when the transition from the decelerating state to the accelerating state is detected, the ignition cut is executed after the predetermined waiting time period over the predetermined time period or the predetermined number of ignition cycles. Accordingly, it is possible to reduce the shock at the transition to the accelerating state

by promptly reducing the engine speed after play existing in the drive system of the vehicle is taken up. As a result, it is possible to reduce the shock at the transition to the accelerating state without deteriorating the acceleration response.

[0006] In the above-described configuration, it is preferable that the acceleration shock reduction control system further include a throttle opening degree sensor which detects a throttle opening degree, and that the transition from the decelerating state to the accelerating state be determined from an output of the throttle opening degree sensor. According to this configuration, the transition from the decelerating state to the accelerating state is determined from the output of the throttle opening degree sensor. This makes it possible to detect the operation of the driver (rider) at an earlier stage, and also to apply the present invention to an existing configuration without making any modification thereon. As a result, an inexpensive acceleration shock reduction control system can be obtained.

[0007] In the above-described configuration, it is preferable that the acceleration shock reduction control system further include revolution sensors which detect the number of rotations of a counter shaft and the number of rotations of a crankshaft, respectively, and that it be determined that the waiting time period elapses, when the difference in the number of rotations between the counter shaft and the crankshaft reaches a predetermined threshold. According to this configuration, it is possible to control, with a higher precision, the reduction in the shock at the transition to the acceleration by utilizing existing sensors. Moreover, the need for a map of the waiting time period can be eliminated.

[0008] In the above-described configuration, it is preferable that the acceleration shock reduction control system further include a map of the throttle opening degree and the engine speed for determining a threshold which divides a large throttle-opening region and a small throttle-opening region, and that the transition from the decelerating state to the accelerating state be determined from a change in the throttle opening degree with respect to the predetermined threshold. According to this configuration, it is possible to detect, with a high precision, the transition from the decelerating state to the accelerating state without using a speed sensor. As a result, it is possible to apply the present invention to a vehicle having no speed sensor mounted thereon.

[0009] In the above-described configuration, it is preferable that the acceleration shock reduction control system further include a gear-position sensor which detects a current gear position, and that a plurality of thresholds be used depending on a current gear position detected by the gear-position sensor. According to this configuration, it is possible to set a threshold more appropriately than otherwise. As a result, it is possible to reduce the shock with a high precision.

[0010] In the above-described configuration, it is preferable that different time periods for the ignition cut be

set in conjunction with ranges of engine speed, and with the gear positions. According to this configuration, it is possible to set an appropriate time period for the ignition cut in accordance with a range of engine speed, and with a gear position. As a result, it is possible to reduce the acceleration shock with a high precision.

[0011] Furthermore, in the above-described configuration, it is preferable that an ignition timing be advanced during the waiting time period. According to this configuration, it is possible to more promptly take up the play existing in the drive system of the vehicle by advancing the ignition timing. As a result, the acceleration response can be further improved.

[Effects of the Invention]

[0012] According to the present invention, when the transition from the decelerating state to the accelerating state is detected, the ignition cut is executed after the predetermined waiting time period over the predetermined time period or the predetermined number of ignition cycles. Accordingly, it is possible to reduce the shock at the transition to the accelerating state without deteriorating the acceleration response.

In addition, the transition from the decelerating state to the accelerating state is determined from the output of the throttle opening degree sensor. Accordingly, it is possible to detect the operation of the driver (rider) at an earlier stage, and also to apply the present invention to an existing configuration without making any modification thereon. As a result, an inexpensive acceleration shock reduction control system can be achieved.

Moreover, the acceleration shock reduction control system according to the present invention includes revolution sensors which detect the number of rotations of the counter shaft and the number of rotations of the crankshaft, respectively. Whether or not the waiting time period elapses is thus determined from the fact that the difference in the number of rotations between the counter shaft and the crankshaft reaches a predetermined threshold. Accordingly, it is possible to control, with a higher precision, the reduction in the shock at the transition to the accelerating state by utilizing existing sensors. Moreover, the need for a map of the waiting time period can be eliminated.

[0013] Furthermore, the acceleration shock reduction control system according to the present invention includes a map of the throttle opening degree and the engine speed for determining a threshold which divides a large throttle-opening region and a small throttle-opening region. The transition from the decelerating state to the accelerating state is thus determined from a change in the throttle opening degree with respect to the predetermined threshold. Accordingly, it is possible to apply the present invention to a vehicle having no speed sensor mounted thereon.

In addition, the acceleration shock reduction control system according to the present invention includes a gear-

position sensor which detects a current gear position. Moreover, a plurality of thresholds are used depending on the current gear position detected by the gear-position sensor. Accordingly, it is possible to set a threshold more appropriately than otherwise. As a result, it is possible to reduce the shock with a high precision.

Moreover, different time periods for the ignition cut are set in conjunction with ranges of engine speed, and with the gear positions. Accordingly, it is possible to set an appropriate time period for the ignition cut in conjunction with a range of engine speed, and with a gear position. As a result, it is possible to reduce the acceleration shock with a high precision.

Furthermore, the ignition timing is advanced during the waiting time period. Accordingly, it is possible to more promptly take up the play existing in the drive system of the vehicle. As a result, the acceleration response can be further improved.

[0014]

Fig. 1 is a side view showing an overall configuration of a motorcycle according to a first embodiment.

Fig. 2 is a side cross-sectional view showing a cylinder head and the peripheral configuration thereof.

Fig. 3 is a view showing the arrangement of sensors and the like.

Fig. 4 is a block diagram showing a control unit and the peripheral configuration thereof.

Fig. 5 is a graph showing a throttle-opening-degree table.

Fig. 6 is a graph showing an acceleration shock reduction control.

Fig. 7 is a graph for explaining a waiting time period and an ignition-cut executing time period.

Fig. 8 is a graph showing a waiting time period setting table.

Fig. 9 is a graph showing an executing time period setting table.

Fig. 10 is a graph showing an acceleration shock reduction control according to a second embodiment.

Fig. 11 is a graph for explaining a difference-determination threshold and an ignition-cut executing time period.

Fig. 12 is a graph showing an acceleration shock reduction control according to a third embodiment.

[0015] Hereinafter, descriptions will be given of embodiments of the present invention with reference to the attached drawings. Note that, in the descriptions, the front, rear, left, right, up, and down directions are of a vehicle body.

Fig. 1 is a side view showing an overall configuration of a motorcycle according to a first embodiment. The motorcycle 1 includes a vehicle body frame 2, a pair of left and right front forks 3, a steering handlebar 4, a front wheel 5, an engine (internal combustion engine) 6, a radiator 7, swing arms 8, a rear wheel 9, a pair of left and right rear cushions 10, a fuel tank 11, and a seat 12. The front forks 3 are rotatably supported by a head pipe 30 disposed on a front portion of the vehicle body frame 2. The handlebar 4 is attached to a top bridge 3A which supports the upper ends of the front forks 3. The front wheel 5 is rotatably supported by the front forks 3. The engine 6 is supported by the vehicle body frame 2 at substantially the center of the vehicle body. The radiator 7 is disposed on the front side of the engine 6. The swing arms 8 are supported by the rear end of the engine 6 and the vehicle body frame 2 to be swingable up and down. The rear wheel 9 is rotatably supported by rear end portions of the swing arms 8. The rear cushions 10 are disposed between rear portions of the swing arms 8 and the vehicle body frame 2. The fuel tank 11 is disposed in the upper portion of the vehicle body frame 2, while the seat 12 is disposed on the rear side of the fuel tank 11.

[0016] A bracket 13 is attached between the top bridge 3A and a bottom bridge 3B, which both support the front forks 3. A headlight 14, turn signals 15, meters 16 and horns 17 are attached to the bracket 13, while a switch box 18 and rearview mirrors 19 are attached to the handlebar 4.

In addition, an air-cleaner side cover 20, a side cover 21, a rear cowl 22, a grab rail 23, and a rear fender 24 are attached to the vehicle body frame 2. A tail light 25, and turn signals 26 are attached to the rear fender 24. A side stand 27 and a main stand 28 are attached to lower portions of the vehicle body frame 2.

[0017] The vehicle body frame 2 includes a pair of left and right main pipes 31, a pair of left and right down tubes 33, as well as a pair of left and right seat rails 34. The main pipes 31 extend from a head pipe 30 toward the rear side of the vehicle body, and are then bent to further extend obliquely toward the lower side of the vehicle body. The down tubes 33 extend from the head pipe 30 below the main pipes 31 toward the lower side of the vehicle body, and are then further extend toward the rear side of the vehicle body. The seat rails 34 are supported, at the front ends thereof, by a cross member 31A which is disposed in the middle of the main pipes 31. The seat rails 34 also extend from the cross member 31A toward the rear side of the vehicle body.

The vehicle body frame 2 further includes a pair of left and right reinforcing frames 35 as well as a pair of left and right reinforcing frames 36. The reinforcing frames 35 link the head pipe 30 to the main pipes 31, while the

reinforcing frames 36 link the reinforcing frames 35 to the corresponding down tubes 33. The rigidity of the vehicle body frame 2 is further enhanced by these reinforcing frames 35 and 36.

[0018] The rear ends of the main pipes 31 are joined respectively to the down tubes 33. A pair of left and right pivot plate portions 37 are joined to the main pipes 31 and the down tubes 33 at the portions where the main pipes 31 and the down tubes 33 are joined to each other. The pivot plate portions 37 pivotally lock the swing arm 8, which support the rear wheel 9.

In addition, the rear ends of the down tubes 33 are joined respectively to the seat rails 34. The seat rails 34 support the seat 12, the rear cowl 22, and the like. Note that, other cross members are arranged on the vehicle body frame 2 as appropriate in addition to the cross member 31A, so that an appropriate frame rigidity is secured by these cross members and the like.

[0019] Plural engine hangers 39 are provided to the main pipes 31 and the down tubes 33, so that the engine 6 is supported with the engine hangers 39.

The engine 6 is thus supported in a space surrounded by the main pipes 31 and the down tubes 33. The engine 6 includes a crankcase 40, a cylinder block 41, a cylinder head 42, and a head cover 43. The cylinder block 41 extends substantially upward from the front portion of the crankcase 40. The cylinder head 42 is joined to the upper portion of the cylinder block 41, while the head cover 43 is joined to the upper portion of the cylinder head 42. The engine 6 is a multi-cylinder (4-cylinder) in-line engine including 4 cylinders arranged in a row in the cylinder block 41.

[0020] In the cylinder block 41, a piston is housed to reciprocate in each of the cylinders. In the crankcase 40, a crankshaft, a counter shaft, an output shaft (main shaft) 45 and the like are axially supported, while the crankshaft is coupled to the pistons with connecting rods. In addition, in the crankcase 40, a power transmission mechanism (clutch mechanism) and a transmission mechanism are housed. The power transmission mechanism connects and disconnects between the crankshaft and the counter shaft.

As shown in Fig. 1, sprockets 46 and 47 are provided respectively to the output shaft 45 and the rear wheel 9. The power of the engine 6 is transmitted to the rear wheel 9 with a drive chain 48 looped between these sprockets 46 and 47. Note that, the motorcycle 1 of this embodiment is provided with a 6-forward-speed transmission system.

[0021] In the cylinder head 42, as shown in Fig. 2, combustion chambers 42A, exhaust ports 50, and intake ports 55 are formed. The top of the piston housed in each cylinder of the engine 6 faces the corresponding one of the combustion chambers 42A. Each of the exhaust port 50 communicates with the corresponding one of the combustion chambers 42A, and opens from the front side of the cylinder head 42.

Each port 50 and each port 55 are provided respectively with an exhaust valve 51 and the intake valve 56 which

open and close the corresponding ports 50 and 55. A valve mechanism 53, which drives the exhaust valves 51 and the intake valves 56 to be opened and closed, is disposed in a valve chamber 42C formed in the upper portion of the cylinder head 42. The upper opening of the valve chamber 42C is blocked by a head cover 43 with a gasket 43A.

[0022] The valve mechanism 53 includes exhaust cams 54 and intake cams 57, which rotate in association with the rotation of the crankshaft. The exhaust valves 51 and the intake valves 56 are biased in the closing directions by valve springs 58. The exhaust cams 54 and the intake cams 57 press down the exhaust valves 51 and the intake valves 56, respectively, to open the corresponding valves 51 and 56. The ports 50 and 55 are thus caused to communicate with the combustion chamber 42A. When the cams 54 and 57 stop pressing, the valves 51 and 56 are closed by reactive force to cut off the communication between the corresponding port 50 and the combustion chamber 43A, and the communication between the corresponding port 55 and the combustion chamber 43A, respectively. In addition, ignition plugs (spark plugs) 59, each of which ignites an air-fuel mixture supplied to the inside of the combustion chamber 42A, are attached to the cylinder head 42.

[0023] As shown in Fig. 1, an exhaust pipe 60 is connected to an exhaust opening 50A of each exhaust port 50. Each of the exhaust pipes 60 extends from the exhaust opening 50A to the lower side of the vehicle body, and then extends to the rear side of the vehicle body below the crankcase 40 to be connected to an exhaust manifold pipe. The exhaust pipes 60 are thus connected to a muffler 62 with the exhaust manifold pipe in between. On the other hand, as shown in Fig. 2, a throttle body 70 is connected to an intake opening of each intake port 55 with an insulator (pipe) 65 in between. Moreover, an air cleaner 80 (see Fig. 1) is contiguously disposed on the rear side of the throttle body 70.

[0024] As shown in Fig. 2, throttle valves 72, which open and close the respective intake ports 55, are disposed on the throttle body 70. Each of the throttle valves 72 opens and closes the corresponding intake port 55 in accordance with the throttle operation of the rider. As a result, the amount of intake air to be supplied from the air cleaner 80 to the corresponding cylinder of the engine 6 is controlled.

In addition, injectors (fuel injection devices) 73 are attached to the throttle body 70 in a manner of facing the respective intake ports 55. Fuel in the fuel tank 11 is supplied to each injector 73 via a fuel pump.

As shown in Fig. 3, throttle sensors (throttle opening degree sensors) SE2 are attached to the throttle body 70. Each throttle sensor SE2 detects the opening degree (throttle opening degree) of the corresponding throttle valve 72 (see Fig. 2) provided in an intake passage of the engine 6. The detection result of the throttle sensor SE2 is outputted to a control unit (ECU) 90 (see Fig. 1). In accordance with the throttle opening degree, the con-

trol unit 90 controls the amount of fuel injection of each injector 73. As a result, the mixture of fuel and air, that is, the air-fuel mixture is supplied from the throttle body 70 to the engine 6.

[0025] As shown in Fig. 1, the air cleaner 80 includes an outside-air introducing portion 81 and a cleaned-air portion 82. Outside air is introduced into the outside-air introducing portion 81. The outside-air introducing portion 81 cleans the outside air with an air filter incorporated in the outside-air introduction section 81, and then supplies the cleaned air to the cleaned-air portion 82. The throttle body 70 is joined to the cleaned-air portion 82, and the cleaned air stored in the cleaned-air portion 82 is supplied to the engine 6 with a negative pressure in the cylinders of the engine 6. The cleaned-air portion 82 here has a capacity in which a required amount of air for the engine 6 can be stored, and functions also as a surge tank which absorbs an intake air pulsation.

[0026] A housing case 95, in which a battery 91 and the control unit 90 are housed, is arranged on the rear side of the air cleaner 80. The control unit 90 is referred also to a PGM-FI (electronically controlled fuel injection system)/IGN unit. As shown in Fig. 4, electronic components, such as various sensors, which are provided to the motorcycle 1, are wired to the control unit 90.

As shown in Fig. 3, the motorcycle 1 is provided with: a rotational-speed sensor (crankshaft pulse generator) SE1 which detects an engine speed (the number of rotations of the crankshaft); a throttle sensor (throttle opening degree sensor) SE2 which detects the throttle opening degree; a speed sensor (rotational-speed sensor) SE3 which detects the number of rotations of the counter shaft (corresponding to the vehicle speed); an ignition system (ignition coil) 76; and the like. As shown in Fig. 4, these electronic components are wired to the control unit 90. Here, the ignition system 76 applies, in accordance with an instruction from the control unit 90, a high voltage to each of the ignition plugs 59 provided to the respective cylinders of the engine 6. As a result, an arc is generated, so that the engine 6 is operated.

Moreover, the motorcycle 1 is provided with: a water-temperature sensor SE4 which detects the temperature of an engine cooling water; a negative-pressure sensor SE5 which detects the negative pressure of air sucked into the engine 6; an atmospheric-pressure sensor SE6 which detects an atmospheric pressure; an intake-air-temperature sensor SE7 which detects the temperature of the intake air of the engine 6; and a gear-position sensor SE8 which detects the current gear position. These sensors are also wired to the control unit 90.

[0027] The control unit (control means) 90 includes a storage device 90A in which various data including a program data, a map, and the like are stored. By executing the program stored in the storage device 90A, the control unit 90 controls the amount and timing of fuel injection of the injectors 73 (fuel injection control), and also controls the ignition system (ignition coil) 76, in accordance with detection results of the above-described sensors.

The control unit 90 thus performs ignition control, and the like, of the engine 6.

[0028] Next, descriptions will be given of a system configuration regarding an acceleration shock reduction control (acceleration shock reduction control system).

Fig. 5 shows a throttle-opening-degree table (map) T1, which is stored in the storage device 90A. The throttle-opening-degree table T1 is a map in which the throttle opening degree Th and the engine speed Ne are associated with each other. A throttle-opening-degree threshold Z1 is firstly determined. When the engine speed Ne and the throttle opening degree Th are on the line of the threshold Z1, driving power is not transmitted from the crankshaft to the rear wheel 9. The throttle opening degree Th on the line of the threshold Z1 is hereinafter referred to as a "zero-horsepower opening degree." This throttle-opening-degree threshold Z1 increases in proportion to the engine speed Ne. A region where the throttle opening degree Th is above the throttle-opening-degree threshold Z1 is determined as a large throttle-opening region α . In this region α , a positive driving power is applied to the rear wheel 9 no matter whether the throttle is opened or closed during the traveling of the vehicle, so that the vehicle is accelerated. On the other hand, a region where the throttle opening degree Th is below the throttle-opening-degree threshold Z1 is determined as a small throttle-opening region β . In this region β , a negative driving power is applied to the rear wheel 9 no matter whether the throttle is opened or closed during the traveling of the vehicle, so that the vehicle is decelerated.

[0029] As this throttle-opening-degree table T1, a two-dimensional table data in which the engine speed Ne and the throttle-opening-degree threshold Z1 are associated with each other may be employed. Alternatively, as this table T1, a three-dimensional table data with which it is possible to determine, from the engine speed Ne and the current throttle opening degree Th, whether the throttle opening degree Th is larger than the throttle-opening-degree threshold Z1 (the current throttle opening degree Th is in the large throttle-opening region α) or smaller than the throttle-opening-degree threshold Z1 (the current throttle opening degree Th is in the small throttle-opening region β). When the two-dimensional table data is employed, the throttle-opening-degree threshold Z1 is firstly determined from a current engine speed Ne. Then, by comparing a current throttle opening degree Th with this threshold Z1, it is possible to determine whether the current throttle opening degree Th is in the large throttle-opening region α or in the small throttle-opening region β . In this case, it is preferable that the throttle-opening-degree threshold Z1 be determined in conjunction not only with the engine speed Ne, but also with each of the gear positions. The setting in this manner enables to precisely determine the throttle-opening-degree threshold Z1, which is the "zero-horsepower opening degree" for each of ranges of various engine speeds Ne as well as for each of the gear positions.

[0030] Suppose a case where the throttle opening de-

gree Th increases, for example as indicated by the thick arrow in Fig. 5, from the small throttle-opening region β to the large throttle-opening region α during the traveling of the vehicle. In this case, the driving power applied to the rear wheel 9 changes from a negative driving power to a positive driving power, so that the state of the vehicle transitions from a decelerating state to an accelerating state. During the transition from the decelerating state to the accelerating state, each component may possibly move from one side to the other within the range of play (backlash or the slack of the drive chain 48) existing in the drive system of the vehicle. As a result, what is termed as an acceleration shock may act on the vehicle.

[0031] In this embodiment, for the purpose of reducing the acceleration shock, the control unit 90 determines whether or not the state of the vehicle transitions from the decelerating state to the accelerating state, from the output of the throttle sensor SE2. When detecting the transition to the accelerating state, the control unit 90 cuts off the ignition for a predetermined executing time period (ignition-cut executing time period) Tr after a predetermined waiting time period Tw elapses.

[0032] Fig. 6 shows the acceleration shock reduction control.

To be specific, Fig. 6 shows the following example. From a state where the engine speed Ne is increased to a predetermined speed, the throttle opening degree Th is once reduced (a deceleration state). Thereafter, the throttle is operated at a timing t0 to again increase the throttle opening degree Th. At a timing t1 when the throttle opening degree Th reaches the throttle-opening-degree threshold Z1 (see Fig. 5) due to the increase, the counting of the waiting time period Tw is started. At a timing t2 when this waiting time period Tw elapses, the signal level of a control signal SS to the ignition system 76 (see Fig. 4) is raised. Accordingly, the ignition operation of the ignition system 76 is stopped, so that the ignition cut starts. Then, at the timing t2 when the ignition cut starts, the counting of the executing time period Tr is started. At a timing t3 when the executing time period Tr elapses, the signal level of the control signal SS is decreased. Accordingly, the ignition operation of the ignition system 76 is restarted, so that the ignition cut ends.

[0033] Since the ignition operation is continued during the waiting time period Tw, the engine speed Ne can be increased more promptly than a case where the ignition operation is retarded. On the other hand, since the ignition operation is stopped during the ignition-cut executing time period Tr, the engine speed Ne can be decreased promptly. With this configuration, the ignition operation is stopped between the timings t2 and t3, and is then operated again under the normal ignition control. Since the time for which the ignition is stopped is very short, the fuel injection may be continued during the ignition cut. It is further preferable to stop also the fuel injection (fuel cut) during the ignition cut.

[0034] If the acceleration shock reduction control is not executed, the ignition operation is continued without per-

forming the ignition cut. Accordingly, as indicated by the dashed line in Fig. 6, the engine speed N_e continues to increase until a timing tx' at which the play (backlash) existing in the drive system of the vehicle is taken up. Then, at the timing tx' when the play existing in the drive system of the vehicle is taken up, the engine speed N_e is forced to decrease to the aforementioned speed N_{e0} . In this case, the so-called acceleration shock at the time of the transition to the accelerating state occurs. An area S , which is indicated by the hatching surrounded by the dashed line in Fig. 6, represents an amount of traveling required for taking up the play existing in the drive system of the vehicle.

[0035] In this embodiment, the waiting time period T_w and the ignition-cut executing time period T_r are set so that the engine speed N_e can be decreased to the speed N_{e0} , which hardly causes the acceleration shock, at the time point when the play is completely taken up (at the timing t_3 when the executing time period T_r elapses). In other words, the waiting time period T_w and the ignition-cut executing time period T_r are set so that the area S , which is indicated by the hatching surrounded by the dashed line in Fig. 6, can be equal to an area that is indicated by the hatching surrounded by the solid line in Fig. 6. According to this setting, once the play is completely taken up, the engine speed N_e is reduced to N_{e0} . Accordingly, even if the state of the vehicle transitions to the accelerating state from this time point, the acceleration shock is hardly caused. In other words, the ignition-cut executing time period T_r is set so that the engine speed N_e that has been increased during the waiting time period T_w can be decreased to the speed N_{e0} , which hardly causes the acceleration shock. The waiting time period T_w is set so that the engine speed N_e can be decreased to N_{e0} when the area S indicated by the hatching during the total time ($T_w + T_r$) reaches the amount of traveling required for taking up the play.

[0036] The control unit 90 performs a monitoring process for determining, from the output of the throttle sensor SE2, whether or not the state of the vehicle transitions from the decelerating state to the accelerating state. To be specific, the control unit 90 obtains, at predetermined cycles, the throttle opening degree Th which is detected by the throttle sensor SE2. The control unit 90 concurrently refers to the throttle-opening-degree table T1 (see Fig. 5) so as to determine the throttle-opening-degree threshold $Z1$ corresponding to the engine speed N_e detected by the rotational-speed sensor SE1. The control unit 90 then compares the throttle opening degree Th and the throttle-opening-degree threshold $Z1$ to determine whether or not the throttle opening degree Th is changed from a value smaller than the throttle-opening-degree threshold $Z1$ to a value larger than the throttle-opening-degree threshold $Z1$. In short, as shown in Fig. 6, at the timing t_1 when the throttle opening degree Th becomes larger than the throttle-opening-degree threshold $Z1$, the control unit 90 determines that the state of the vehicle transitions from the decelerating state to the

accelerating state.

[0037] Next, descriptions will be given of the relation between the waiting time period T_w and the ignition-cut executing time period T_r .

Now, refer to Fig. 7. Suppose the case of setting a waiting time period T_{wa} that is shorter than the aforementioned waiting time period T_w . In this case, as indicated by the alternate long and short dash line, the ignition cut is executed at a timing t_{2a} that is earlier than the aforementioned timing t_2 for the engine speed N_e . Accordingly, the engine speed N_e is reduced to the speed N_{e0} , which does not cause the acceleration shock, before the area $S2$ surrounded by the alternate long and short dash line reaches an area corresponding to the total amount of play. For this reason, the play cannot be completely taken up during the ignition cut. Since the engine speed is increased again due to the restarting of the ignition operation, the acceleration shock eventually occurs.

On the other hand, suppose the case of setting a waiting time period T_{wb} that is longer than the aforementioned waiting time period T_w . In this case, as indicated by the alternate long and two short dashes line, the ignition cut is executed at a timing t_{2b} that is later than the aforementioned timing t_2 for the engine speed N_e . Accordingly, the engine speed N_e is higher than the speed N_{e0} , which does not cause the acceleration shock, at a time point ty' when the area $S3$ surrounded by the alternate long and two short dashes line reaches the area corresponding to the total amount of play. For this reason, the acceleration shock eventually occurs.

[0038] As described above, when the waiting time period is decreased or increased, it is impossible to reduce the engine speed N_e to the speed N_{e0} , which does not cause the acceleration shock, at a time point when the area S surrounded by the curve showing the time-variable characteristic of the engine speed N_e reaches the area corresponding to the total amount of play. In other words, the waiting time period T_w and the ignition-cut executing time period T_r are uniquely determined (see Fig. 5).

[0039] In this embodiment, the waiting time period T_w and the ignition-cut executing time period T_r that satisfy the above-described conditions are employed. Accordingly, in comparison with a case where the ignition operation is continued without performing the ignition cut, it is possible to reduce the acceleration shock more. In addition, in comparison with a case where the ignition timing of the engine 6 is retarded, it is possible to reduce the acceleration shock without delaying the total amount of time (for example, corresponding to $T_w + T_r$) until the start of acceleration.

[0040] The waiting time period T_w and the ignition-cut executing time period T_r can be obtained by means of, for example, an experiment or a simulation. In this embodiment, a waiting time period setting table T2 shown in Fig. 8 and an execution-time setting table T3 shown in Fig. 9 are stored beforehand in the storage device 90A of the control unit 90 so that the waiting time period T_w

and the executing time period T_r that are obtained in advance can be determined.

As the waiting time period setting table T2 shown in Fig. 8, employed is a map in which the engine speed N_e and the waiting time period T_w are associated with each other. On the other hand, as the execution-time setting table T3 shown in Fig. 9, employed is a map in which the engine speed N_e and the executing time period T_r are associated with each other.

[0041] In this embodiment, as shown in Figs. 8 and 9, the waiting time period T_w and the ignition-cut executing time period T_r are varied in conjunction not only with the engine speed N_e , but also with the gear positions. The waiting time period T_w and the executing time period T_r can be individually set for each of all the first to sixth speed gear positions. Accordingly, these time periods T_w and T_r can be determined appropriately for the acceleration shock reduction in conjunction with a region of the engine speed N_e as well as with each of the gear positions.

Note that, it is also possible to simplify the configuration by omitting the controlling of a high speed region of a high gear position. For example, as shown in Figs. 8 and 9, it is possible to omit the controlling of a high speed region Ar_5 when the fifth speed gear position is selected, while omitting the controlling of a high speed region Ar_6 that includes a low speed area of the high speed region Ar_5 when the sixth speed gear position is selected. It should be noted that the reason why the controlling of a wider high speed region is omitted when the sixth speed gear position is selected is because the acceleration shock is smaller for a higher speed area of a higher speed gear position.

[0042] In this case, as shown in Fig. 8, the waiting time period T_w is set to be shorter as the engine speed N_e is increased, and concurrently to be shorter for a higher gear position (as the gear is shifted closer to the sixth speed). On the other hand, the executing time period T_r is set to be longer as the engine speed N_e is increased, and concurrently to be shorter for a higher gear position. In this case, when the state of the vehicle transitions from the decelerating state to the accelerating state, the control unit 90 obtains the engine speed N_e from the output of the rotational-speed sensor SE1, and concurrently obtains the gear position from the output of the gear-position sensor SE8. On the basis of these obtained information, the control unit 90 determines appropriate waiting time period T_w and executing time period T_r to execute the acceleration shock reduction control.

[0043] As described above, in this configuration, when the transition from the decelerating state to the accelerating state is detected from the output of the throttle sensor SE2, the ignition cut is executed for the predetermined executing time period T_r after the predetermined waiting time period T_w elapses. Accordingly, it is possible to reduce the acceleration shock by promptly reducing the engine speed N_e after the play existing in the drive system of the vehicle is promptly taken up, in comparison

with a case where the ignition timing of the engine 6 is retarded. As a result, it is possible to reduce the acceleration shock without deteriorating the acceleration response.

Moreover, in this configuration, the waiting time period T_w and the ignition-cut executing time period T_r are set in conjunction with ranges of the engine speed N_e , and with the gear positions. Accordingly, it is possible to set, with high precision, appropriate waiting time period T_w and the ignition-cut executing time period T_r . Specifically, with the waiting time period T_w and the ignition-cut executing time period T_r , the engine speed N_e can be reduced to the speed N_{e0} , which does not cause the acceleration shock, at the time point when the area S surrounded by the curve showing the time-variable characteristic of the engine speed N_e reaches the area corresponding to the total amount of play. For this reason, the acceleration shock can be reduced more efficiently.

[0044] In addition, in this configuration, the transition from the decelerating state to the accelerating state is determined on the basis of the throttle opening degree Th by referring to the throttle-opening-degree table T1 in which the throttle opening degree Th and the engine speed N_e are associated with each other. Accordingly, it is possible to detect, with a high precision, the transition from the decelerating state to the accelerating state without using the speed sensor SE3. For this reason, this acceleration shock reduction control can be employed to a vehicle that is not equipped with the speed sensor SE3. In addition, in this configuration, the transition from the decelerating state to the accelerating state is determined from the output of the throttle sensor SE2. This makes it possible to detect the operation of the driver (rider) at an earlier stage. This also makes it possible to detect the transition to the accelerating state without making any modification on the existing structure, so as to configure an inexpensive acceleration shock reduction control system.

40 Second Embodiment

[0045] Fig. 10 shows an acceleration shock reduction control according to a second embodiment. In the second embodiment, a difference between an engine speed (the number of rotations of the crankshaft) N_e and the number of rotations of the counter shaft (corresponding to the vehicle speed) C is monitored. Then, an ignition cut is started at a timing t_2' when the difference exceeds a predetermined threshold (hereinafter, referred to as a difference-determination threshold) Z_2 . Note that, since configurations of the other parts are substantially the same as those of the first embodiment, descriptions thereof will be omitted.

As shown in Fig. 10, the control unit 90 firstly determines, from the output of the throttle sensor SE2, whether or not the state of the vehicle transitions from the decelerating state to the accelerating state. Upon determining that the throttle opening degree Th exceeds the throttle-opening-

degree threshold Z1, that is, upon determining that the state of the vehicle transitions to the accelerating state (t1), the control unit 90 starts monitoring the ratio between the engine speed Ne, detected by the rotational-speed sensor SE1, and the number of rotations C of the counter shaft, detected by the speed sensor SE3 (hereinafter, the ratio will be referred to as the value Ne/C).

[0046] Under this monitoring, the control unit 90 determines whether or not the value Ne/C reaches the predetermined difference-determination threshold Z2. When the value Ne/C reaches the difference-determination threshold Z2 (t2'), the control unit 90 determines that the waiting time period elapses. The control unit 90 thus raises the signal level of a control signal SS to the ignition system 76. Accordingly, the ignition operation of the ignition system 76 is stopped, so that the ignition cut is started. In addition, when the value Ne/C reaches the difference-determination threshold Z2 (t2'), the control unit 90 start counting an executing time period Tr'. Then, at the timing t3 when the executing time period Tr' elapses, the control unit 90 decreases the signal level of the control signal SS. Accordingly, the ignition operation of the ignition system 76 is restarted, so that the ignition cut ends.

[0047] The difference-determination threshold Z2 and the ignition-cut executing time period Tr' are set, as shown in Fig. 10, to satisfy the following conditions. Specifically, with the setting, at a time point (t3') when an area S' surrounded by a curve showing the time-variable characteristic of the engine speed Ne reaches an area corresponding to the total amount of play, the engine speed Ne is reduced to the speed Ne0, which does not cause the acceleration shock.

Now, refer to Fig. 11. Suppose the case of setting a threshold Z2a that is smaller than the difference-determination threshold Z2. In this case, as indicated by the alternate long and short dash line, the ignition cut is executed at a timing t2a' that is earlier than that of the case of setting the difference-determination threshold Z2 for the engine speed Ne. Accordingly, the engine speed Ne is reduced to the speed Ne0, which does not cause the acceleration shock, before the area S2' surrounded by the alternate long and short dash line reaches an area corresponding to the total amount of play. For this reason, the play cannot be completely taken up during the ignition cut. Since the engine speed is increased again due to the restarting of the ignition operation, the acceleration shock eventually occurs.

[0048] On the other hand, suppose the case of setting a threshold Z2b that is larger than the aforementioned difference-determination threshold Z2. In this case, as indicated by the alternate long and two short dashes line, the ignition cut is executed at a timing t2b' that is later than that of the case of setting the difference-determination threshold Z2 for the engine speed Ne. Accordingly, the engine speed Ne is higher than the speed Ne0, which does not cause the acceleration shock, at a time point ty' when the area S3' surrounded by the alternate long

and two dashes line reaches the area corresponding to the total amount of play. For this reason, the acceleration shock eventually occurs.

[0049] As described above, when the value of the difference-determination threshold Z2 is changed, it is impossible to reduce the engine speed Ne to the speed Ne0, which does not cause the acceleration shock, at a time point when the area S' surrounded by the curve showing the time-variable characteristic of the engine speed Ne reaches the area corresponding to the total amount of play. In other words, the difference-determination threshold Z2 and the ignition-cut executing time period Tr' are uniquely determined.

[0050] In this embodiment, the difference-determination threshold Z2 and the ignition-cut executing time period Tr that satisfy the above-described conditions are employed. Accordingly, it is possible to reduce the acceleration shock. Note that, when the difference-determination threshold Z2 satisfying the above-described conditions is set, the timing t2' when the value Ne/C exceeds the threshold Z2 is substantially equal to the timing t2 when the waiting time period Tw elapses, which is shown in the first embodiment. Concurrently, the timing t3' for the ignition cut is also substantially equal to the timing t3 in the first embodiment.

[0051] The difference-determination threshold Z2 and the ignition-cut executing time period Tr' can be obtained by means of, for example, an experiment or a simulation. In this embodiment, a map is stored beforehand in the storage device 90A so that the difference-determination threshold Z2 that is obtained in advance can be determined. In this map, the engine speed Ne and the difference-determination threshold Z2 are associated with each other. In addition, in this map, the difference-determination threshold Z2 is set to be different for each of the gear positions. This makes it possible to determine an appropriate difference-determination threshold Z2 in conjunction with the engine speed Ne, as well as with each of the gear positions so as to reduce the shock.

[0052] As described above, in this configuration, the difference-determination threshold Z2 and the ignition-cut executing time period Tr' that satisfy the above-described conditions are employed. Accordingly, during monitoring the value Ne/C from the timing t1 for the transition to the accelerating state, it is possible to promptly take up the play by continuing the ignition operation. In addition, after the value Ne/C reaches the difference-determination threshold Z2, it is possible to promptly reduce, by the ignition cut, the engine speed Ne to the speed Ne0, which hardly causes the acceleration shock by the ignition cut, and to then start acceleration. Accordingly, as in the case of the first embodiment, it is possible to reduce the acceleration shock without deteriorating the acceleration response.

[0053] Moreover, in this configuration, the existing rotational-speed sensor SE1 and the existing speed sensor SE3 are employed. Then, the ignition cut is started by determining whether or not the waiting time period elapses

es from the outputs of these sensors. Accordingly, it is possible to detect, with a high precision, a timing for starting the ignition cut without installing other components such as a sensor. Furthermore, since the measuring of the waiting time period is unnecessary, the map for the waiting time period T_w (the waiting time period setting table T2), which is used in the first embodiment, is not required.

It should be noted that, the case of monitoring the ratio between the engine speed N_e and the number of rotations C of the counter shaft (the value N_e/C) has been described. However, the ratio is not limited to the value obtained by dividing the engine speed N_e by the number of rotations C of the counter shaft. Alternatively, a value obtained by dividing the number of rotations C of the counter shaft by the engine speed N_e may be employed. The point is that it is possible to employ any value as long as the difference between the engine speed N_e and the number of rotations C of the counter shaft can be determined from the value.

Third Embodiment

[0054] Fig. 12 shows an acceleration shock reduction control according to a third embodiment. In the third embodiment, when the transition from the decelerating state to the accelerating state is detected from the output of the throttle sensor SE2, the ignition timing of the engine 6 is advanced. The engine speed N_e is thus promptly increased, so that the play existing in the drive system of the vehicle is more promptly taken up. Note that, since configurations of the other parts are substantially the same as those of the first embodiment, descriptions thereof will be omitted.

As shown in Fig. 12, the control unit 90 firstly determines, from the output of the throttle sensor SE2, whether or not the state of the vehicle transitions from the decelerating state to the accelerating state. When determining that the throttle opening degree Th exceeds the throttle-opening-degree threshold $Z1$, that is, when determining that the state of the vehicle transitions to the accelerating state ($t1$), the control unit 90 starts counting a predetermined ignition advancing time period (a waiting time period to the ignition cut) T_g . Concurrently, the control unit 90 raises the signal level of the control signal SS to the ignition system 76. Accordingly, the ignition timing of the ignition system 76 is advanced so that the play can be more promptly taken up.

[0055] Subsequently, at a timing $t2$ when the ignition advancing time period T_g elapses, the control unit 90 stops the ignition operation of the ignition system 76 to start the ignition cut, and concurrently starts counting an executing time period Tr . Then, at a timing $t3$ when the executing time period Tr elapses, the control unit 90 raises the signal level of the control signal SS . Accordingly, the ignition operation of the ignition system 76 is restarted, so that the ignition cut ends.

[0056] The ignition-advancing time period T_g and the

ignition-cut executing time period Tr are set, as shown in Fig. 10, to satisfy the following conditions. Specifically, with the setting, at a time point ($t3$) when an area S surrounded by a curve showing the time-variable characteristic of the engine speed N_e reaches an area corresponding to the total amount of play ($t3$), the engine speed N_e is reduced to the speed N_{e0} , which does not cause the acceleration shock. The ignition-advancing time period T_g and the ignition-cut executing time period Tr are uniquely determined in accordance with conditions on advancing the ignition timing. For example, when the ignition timing is advanced to a large extent, the ignition-advancing time period T_g becomes short. On the other hand, when the ignition timing is advanced to a little extent, the ignition-advancing time period T_g becomes long.

Accordingly, the ignition-advancing time period T_g and the ignition-cut executing time period Tr can be obtained by means of, for example, an experiment or a simulation. In this embodiment, a map is stored beforehand in the storage device 90A so that the ignition-advancing time period T_g can be determined. In this map, the engine speed N_e and the ignition-advancing time period T_g are associated with each other. In addition, in this map, the ignition-advancing time period T_g is set to be different for each of the gear positions. This makes it possible to determine an appropriate ignition-advancing time period T_g in conjunction with the engine speed N_e , as well as with each of the gear positions so as to reduce the shock.

[0057] As described above, in this configuration, the play existing in the drive system of the vehicle can be promptly taken up by advancing the ignition timing of the engine 6 during the waiting time period (the ignition-advancing time period T_g) to the ignition cut. Accordingly, it is possible to reduce the acceleration shock while improving the acceleration response, in comparison with the first and second embodiments.

[0058] The present invention has been described so far with reference to the embodiments. However, it is to be clearly understood that the present invention is not limited to these embodiments. For example, in the above-described embodiments, descriptions have been given of the case where the ignition cut is executed over a predetermined time period (Tr , Tr' , or Tr'') after a predetermined waiting time period (T_w) elapses. However, the present invention is not limited to this case. The ignition cut may be executed over a predetermined number of ignition cycles after a predetermined waiting time period (T_w) elapses. In this case, the ignition cut may be executed over a predetermined number of ignition cycles. How many cycles over which the ignition cut is executed is preferably set to be different in conjunction with the engine speed N_e , and with the gear positions.

In addition, in the above-described embodiments, descriptions have been given of the case where the present invention is applied to a motorcycle on which a multi-cylinder engine is mounted. However, the present invention is not limited to this case, and may be applied also

to a motorcycle on which a single-cylinder engine is mounted. Moreover, descriptions have been also given of the case where the present invention is applied to an acceleration shock reduction control system of a motorcycle. However, the present invention is not limited to this case, and may be applied also to an acceleration shock reduction control system of a three-wheeled vehicle or a four-wheeled vehicle, which is categorized as the ATV (all-terrain vehicle).

[0059]

1	motorcycle	
2	vehicle body frame	
6	engine (internal combustion engine)	
5	front wheel	
9	rear wheel	
73	injector	
76	ignition system	
90	control unit (control means)	
Ne	engine speed	
SE1	rotational-speed sensor	
SE2	throttle sensor (throttle opening degree sensor)	
SE3	speed sensor (revolution sensor)	
SE4	water-temperature sensor	
SE5	negative-pressure sensor	
SE6	atmospheric-pressure sensor	
SE7	intake-air-temperature sensor	
SE8	gear-position sensor	
Tg	ignition advancing time period	
Th	throttle opening degree	
Tr, Tr', Tr''	executing time period (ignition-cut executing time period)	
T1	throttle-opening-degree table	
T2	waiting time period setting table	
T3	executing-time setting table	
Z1	throttle-opening-degree threshold	
Z2	difference-determination threshold (ignition-cut starting threshold)	

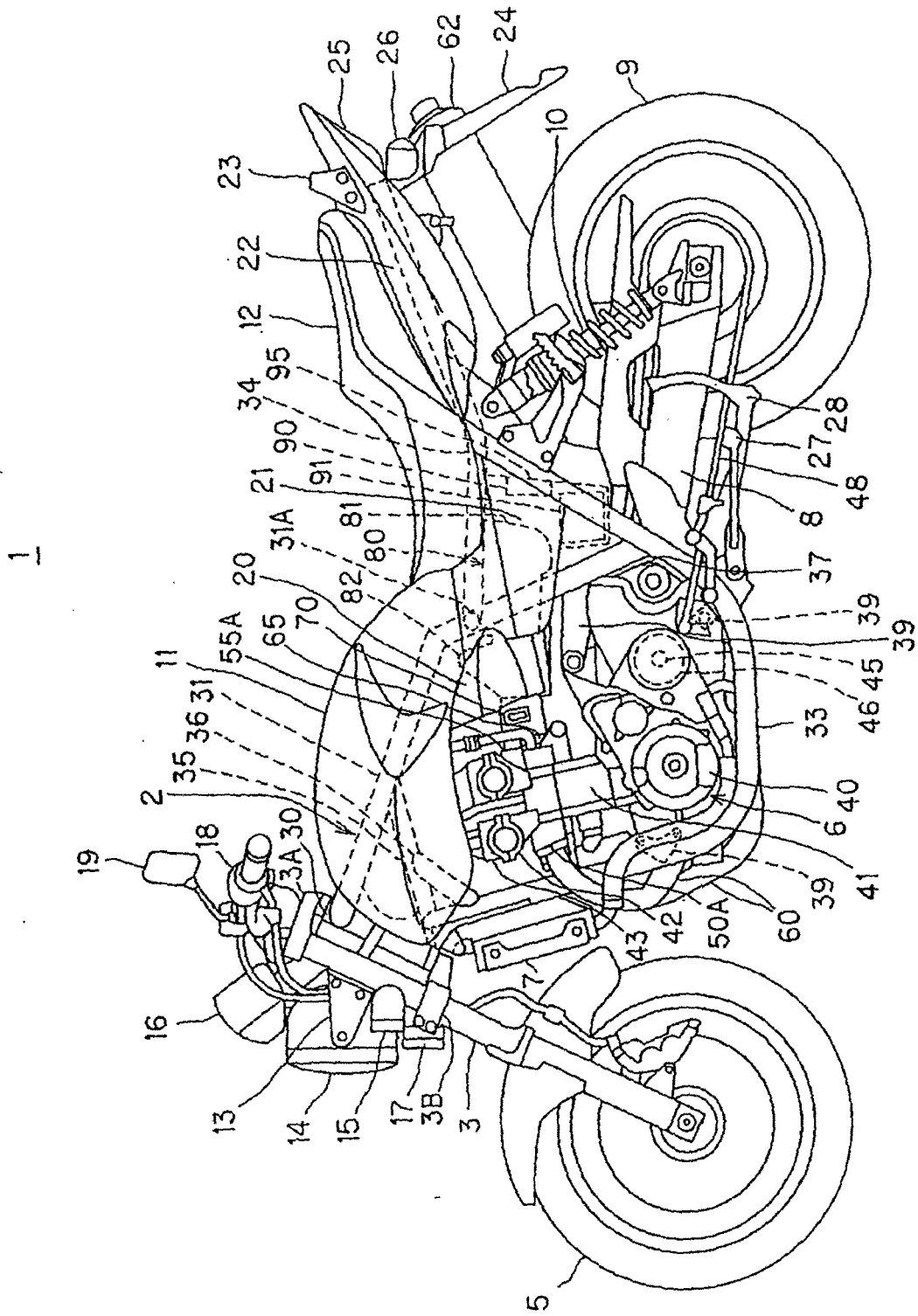
Claims

1. An acceleration shock reduction control system for vehicle, comprising control means (90) which determines a transition from a decelerating state to an accelerating state, and which thus controls the ignition of an internal combustion engine (6) to adjust an output of the engine(6), wherein upon detecting the transition from the decelerating state to the accelerating state, the control means (90) gives an instruction for an ignition cut which is executed, after a predetermined waiting time period (Tw), over a predetermined time period (Tr, Tr', Tr'') or a predetermined number of ignition cycles.
2. The acceleration shock reduction control system for vehicle according to claim 1, further comprising a

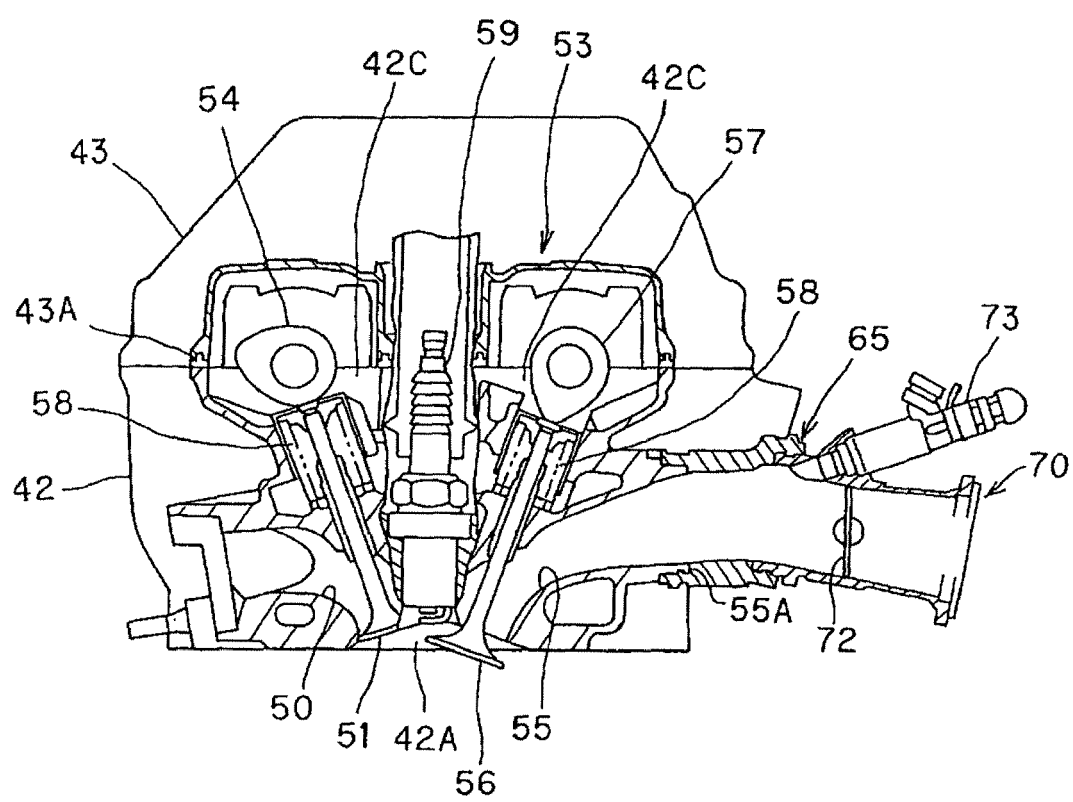
throttle opening degree sensor which detects a throttle opening degree (Th), wherein the transition from the decelerating state to the accelerating state is determined from an output of the throttle opening degree sensor.

3. The acceleration shock reduction control system for vehicle according to any one of claims 1 and 2, further comprising revolution sensors which detect the number of rotations of a counter shaft and the number of rotations of a crankshaft, respectively, wherein when the difference in the number of rotations between the counter shaft and the crankshaft reaches a predetermined threshold, it is determined that the waiting time period elapses.
4. The acceleration shock reduction control system for vehicle according to any one of claims 1 to 3, further comprising a map of the throttle opening degree (Th) and the engine speed (Ne) for determining a threshold which divides a large throttle-opening region and a small throttle-opening region, wherein the transition from the decelerating state to the accelerating state is determined from a change in the throttle opening degree (Th) with respect to a predetermined threshold.
5. The acceleration shock reduction control system for vehicle according to any one of claims 1 to 4, further comprising a gear-position sensor (SE8) which detects a current gear position, wherein a plurality of thresholds are used depending on a current gear position detected by the gear-position sensor (SE8).
6. The acceleration shock reduction control system for vehicle according to any one of claims 1 to 5, wherein different time periods for the ignition cut are set in conjunction with ranges of engine speed (Ne), and with the gear positions.
7. The acceleration shock reduction control system for vehicle according to any one of claims 1 to 6, wherein an ignition timing is advanced during the waiting time period.

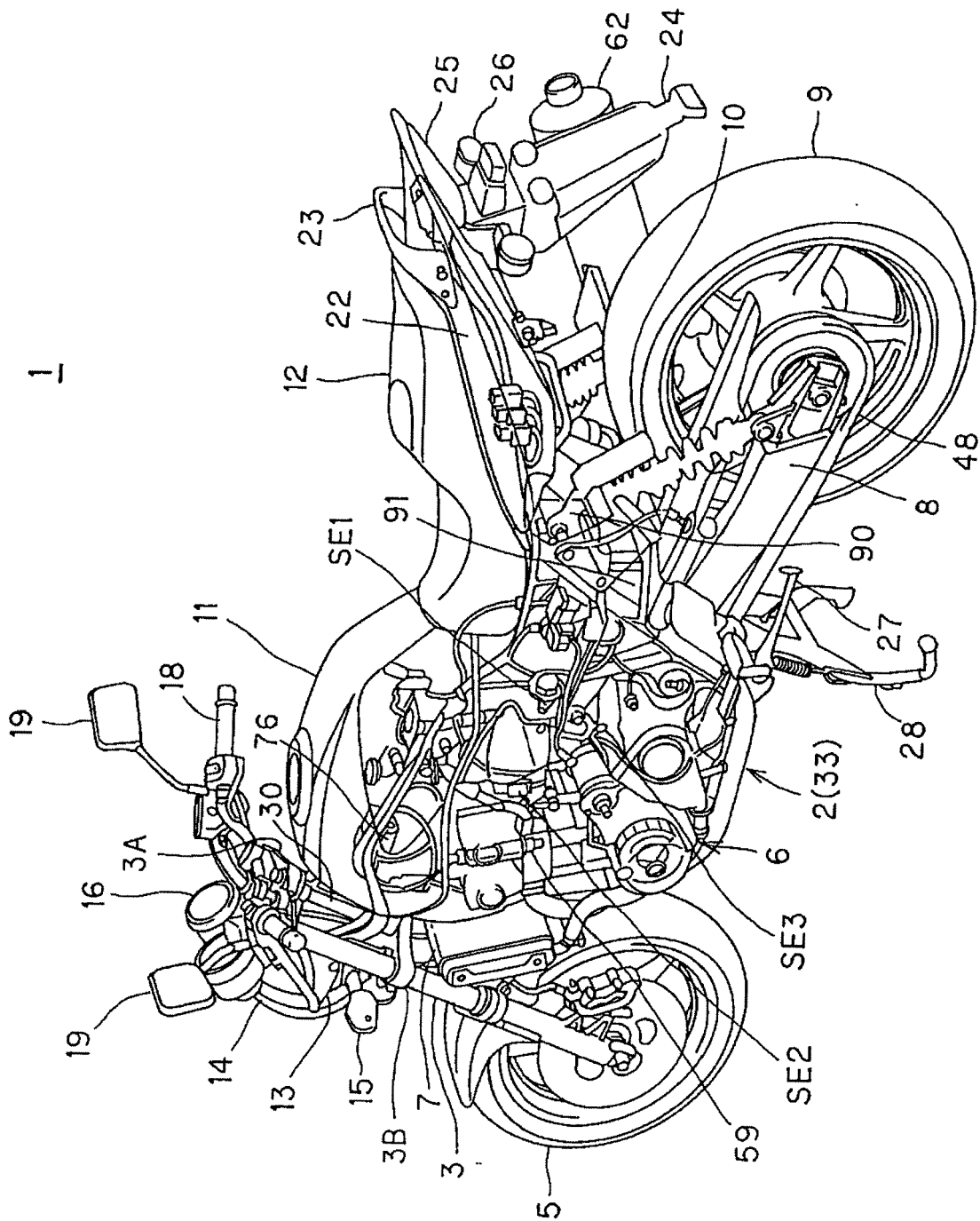
[FIG. 1]



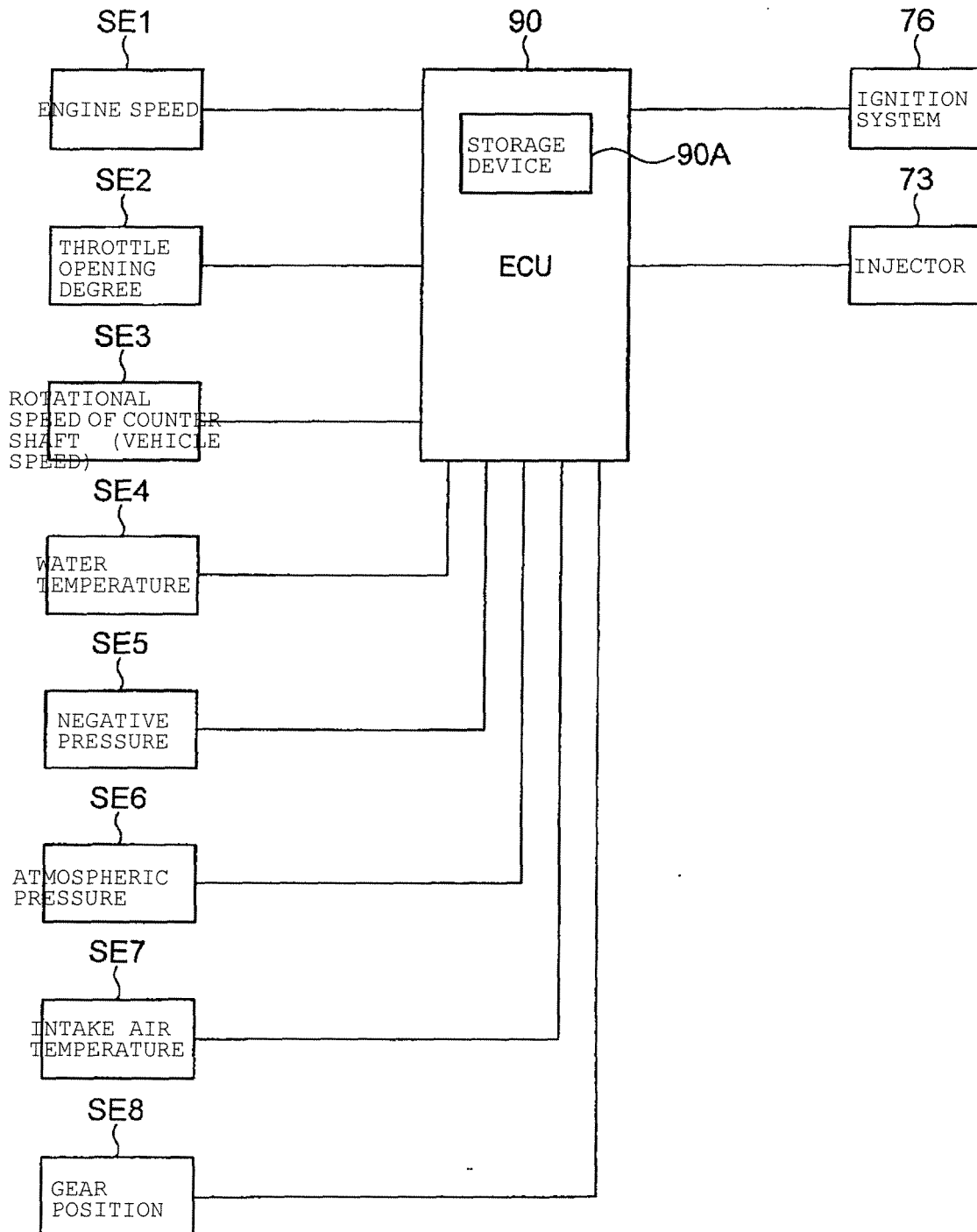
[FIG. 2]



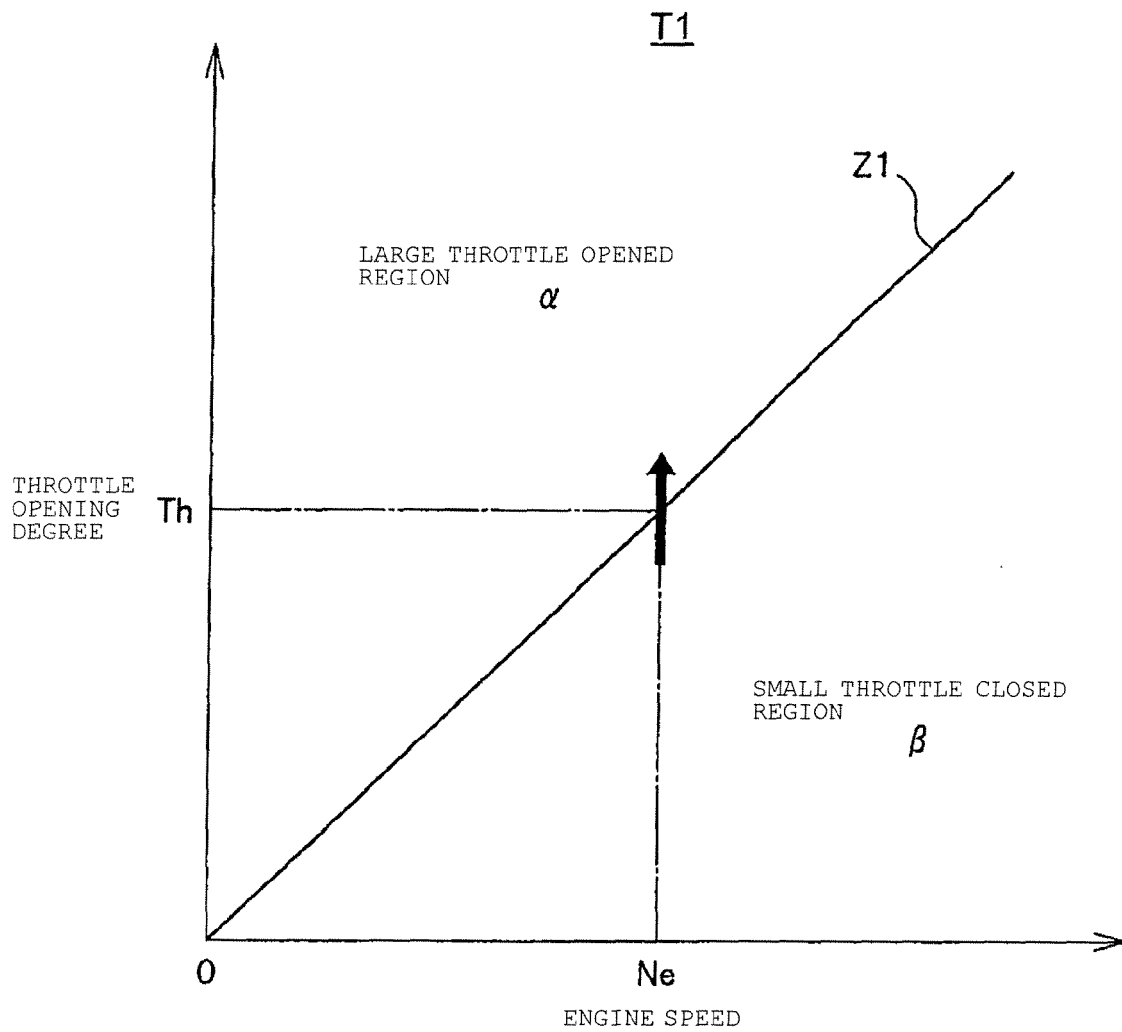
[FIG. 3]



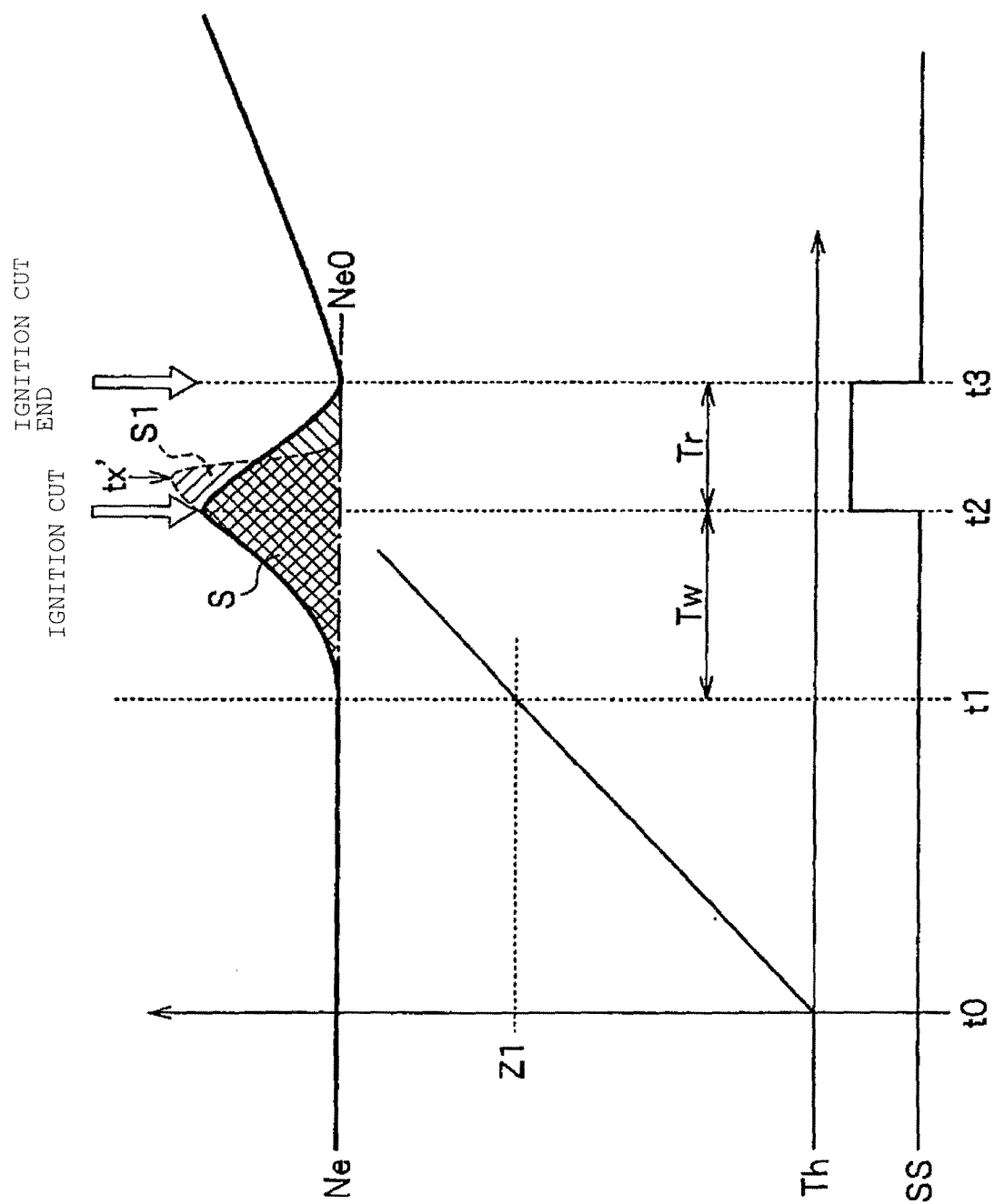
[FIG. 4]



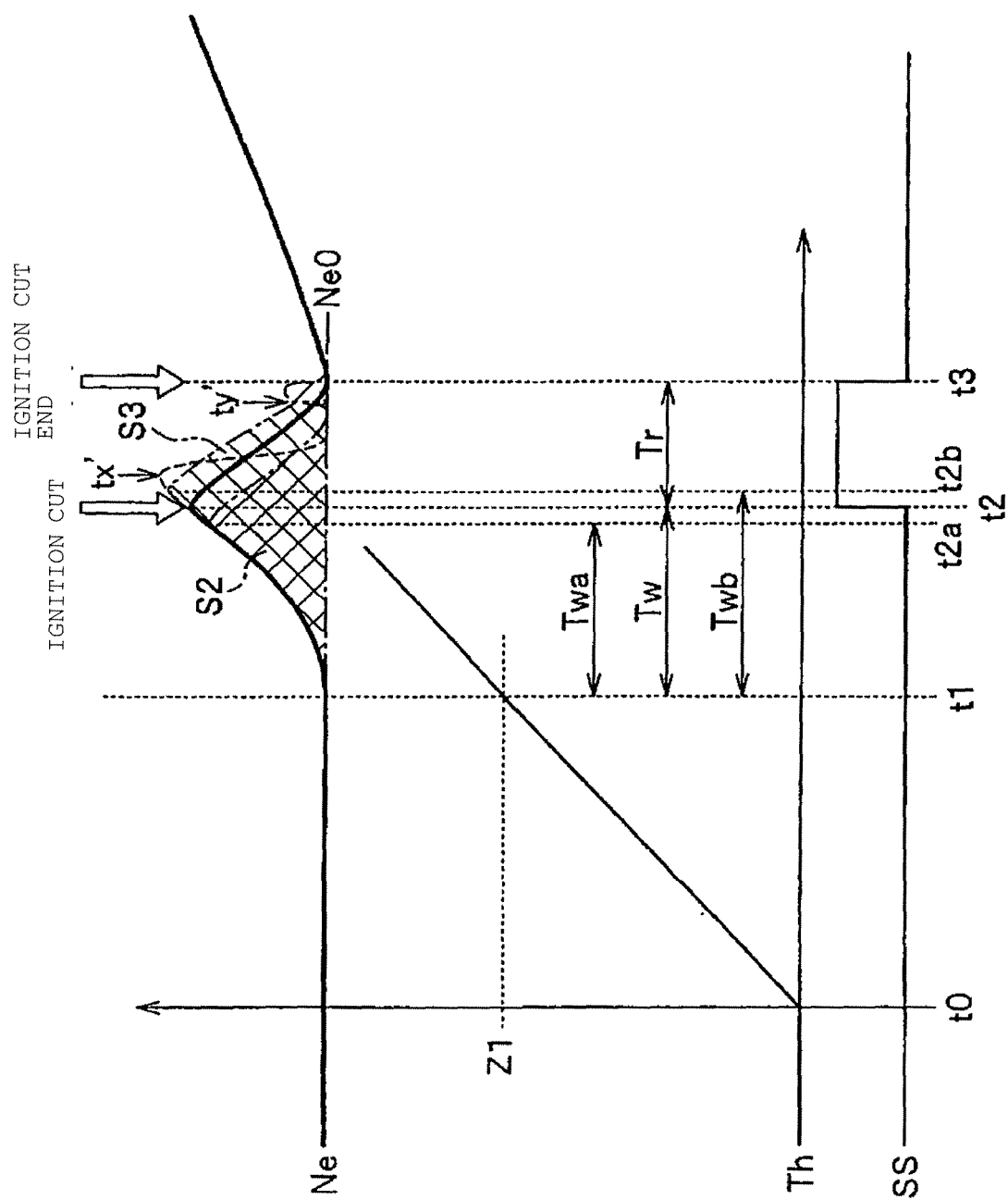
[FIG. 5]



[FIG. 6]



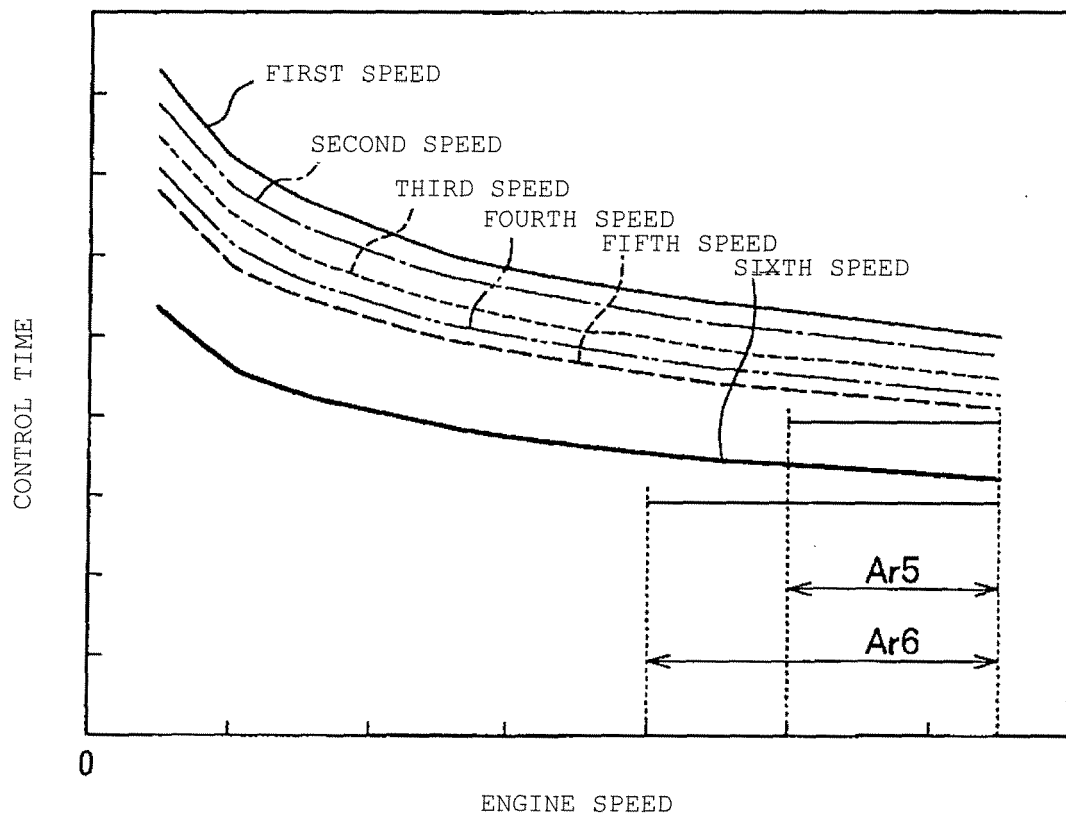
[FIG. 7]



[FIG. 8]

T2

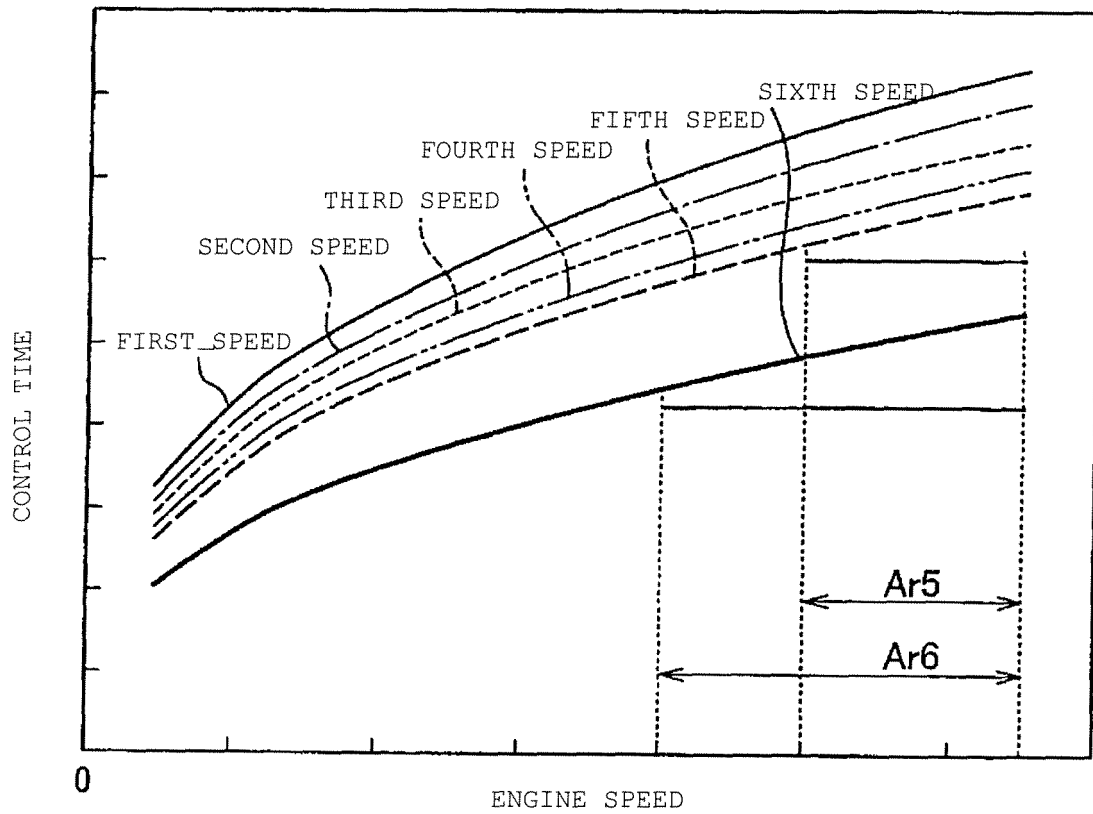
WAITING TIME PERIOD T_w



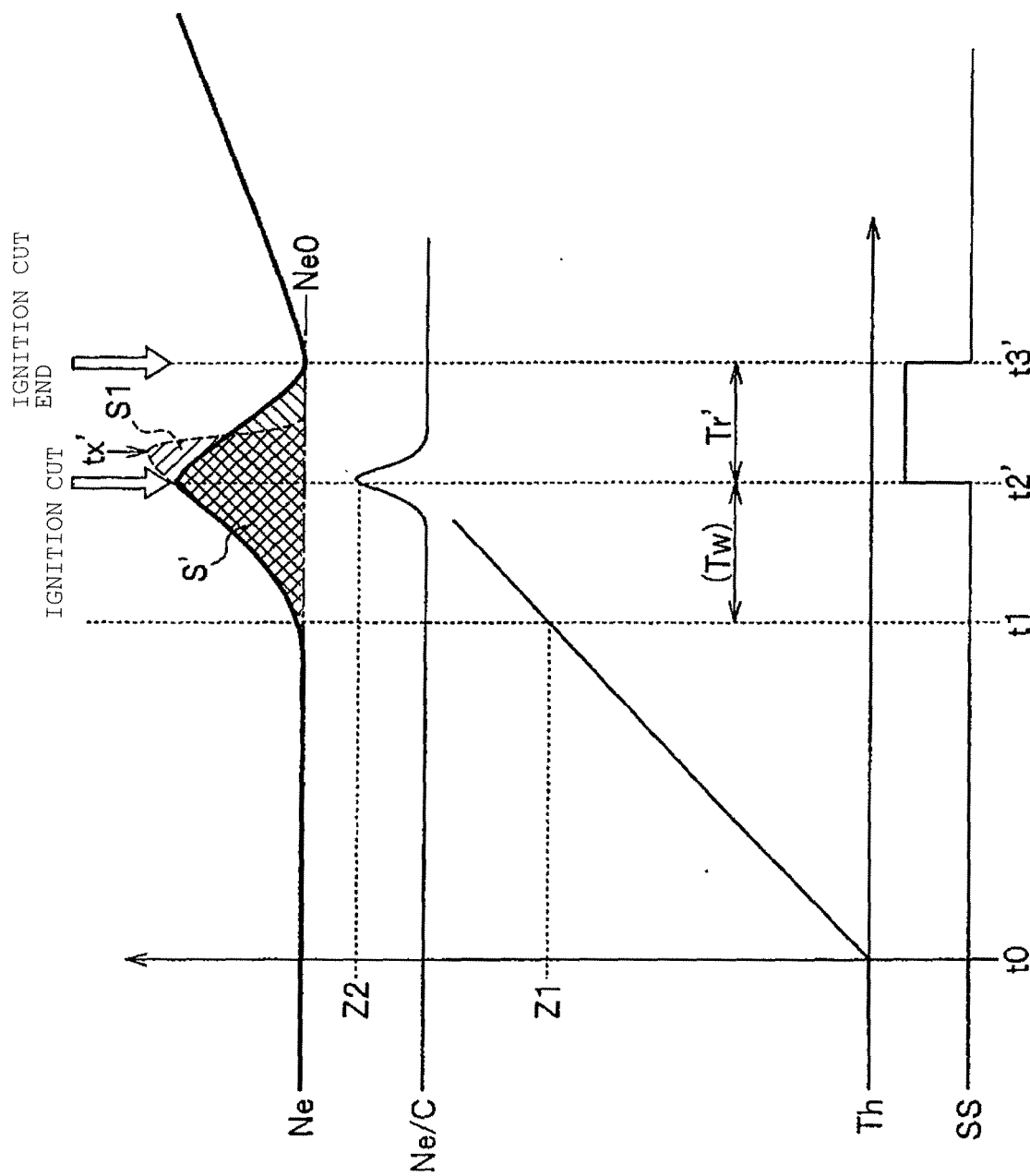
[FIG. 9]

T3

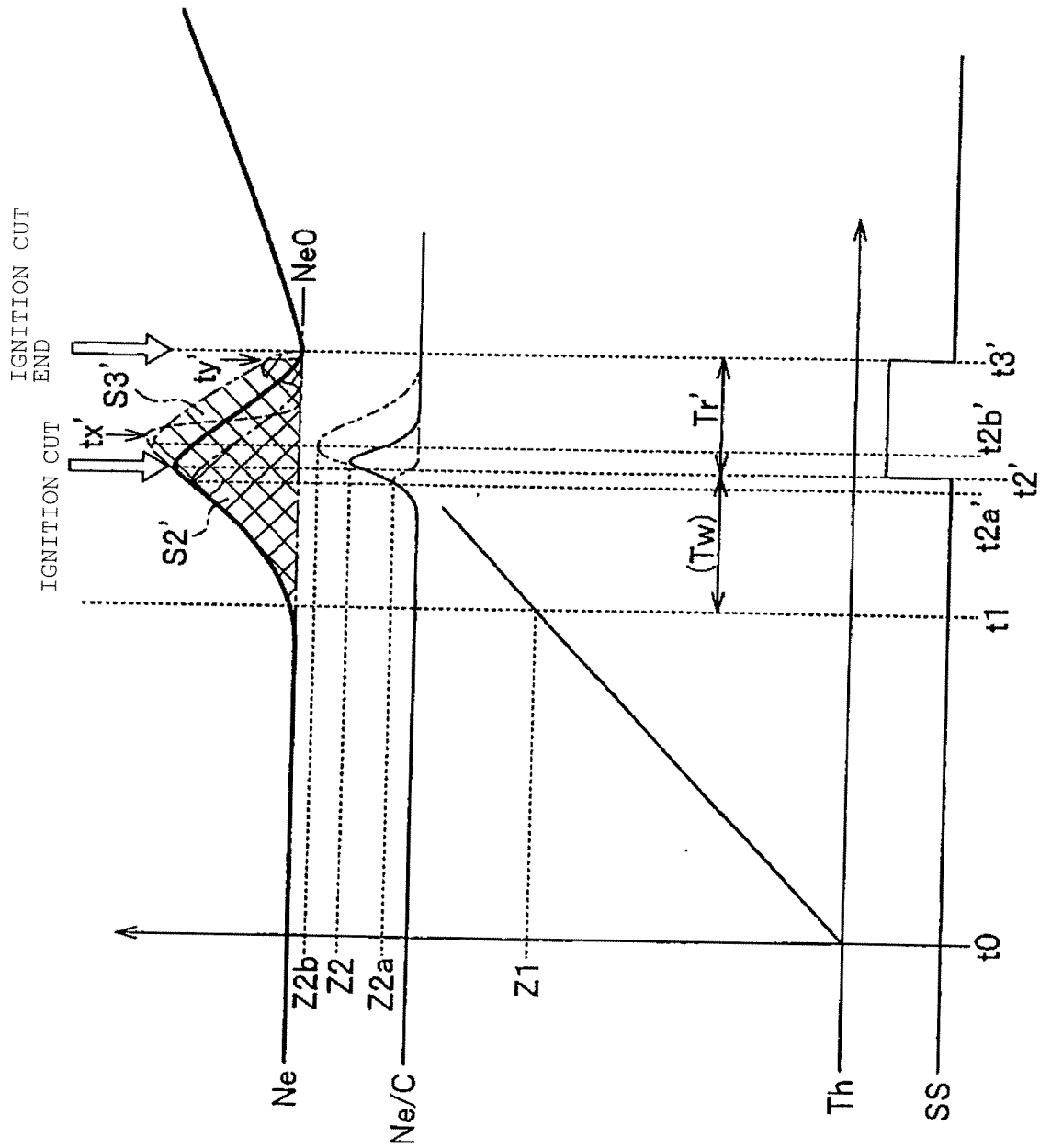
EXECUTING TIME PERIOD (IGNITION-CUT TIME PERIOD) T_r



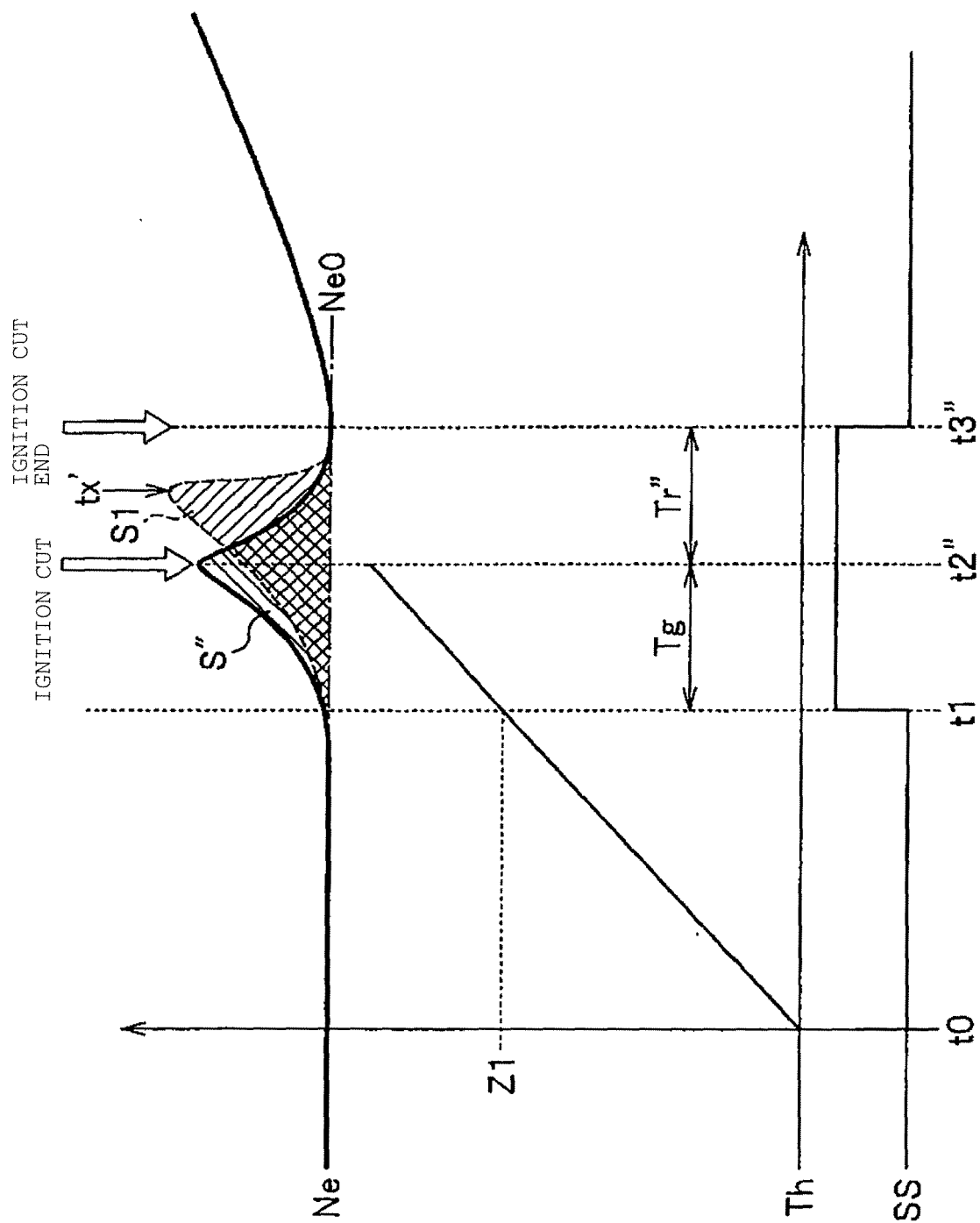
[FIG. 10]



[FIG. 11]



[FIG. 12]





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 07 12 2518

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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